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P Aarthi Helen

Department of Entomology
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

ND Tamboli

Department of Entomology
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

SR Kulkarni

Department of Entomology
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

SA More

Department of Entomology
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

JS Kumbhar

Department of Agri-Economics
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

Biology of fall armyworm *Spodoptera frugiperda* (J.E. Smith) on maize under laboratory conditions

P Aarthi Helen, ND Tamboli, SR Kulkarni, SA More and JS Kumbhar

Abstract

The investigations were carried out on study of biology of Fall armyworm *Spodoptera frugiperda* (J. E. Smith) on maize under laboratory conditions (65^o C and 25 % RH). Mean life span in male and female moth was 36.2 and 38.2 days, respectively. Fecundity varied from 957 to 1289 eggs / female. Mean egg hatching was 96 per cent. Incubation period varied from 3 to 4 days. Larval period ranged from 16-18 days wherein first, second, third, fourth, fifth and sixth instars were 2.8, 2.5, 2.1, 2.2, 2.6 and 4.4 days, respectively. Pupal period varied from 8 to 12 days. Longevity of male and female varied from 11 to 13 and 10 to 11 days, respectively.

Keywords: fall armyworm, *Spodoptera frugiperda*, life span, morphometrics

Introduction

In Maize, the fall armyworm attacks in all the stages of plant from seedling until tasseling and causing defoliation, killing the young plant, resulting in grain damage and subsequently reduces quantity and quality of yield (Chimweta *et al.*, 2019) ^[1]. The fall armyworm is native to the tropical region of the western hemisphere from the United States to Argentina. The first infestation of this pest in India was found on maize crop during Karnataka in May - June 2018 (Sharansabasappa *et al.*, 2018) ^[7] and thereafter it was reported in different states on several crops like sorghum, cotton, sugarcane, rice, tomato, soybean and other millets. Biology is the primer that provides the basic needed informative background of related pest that helps in efficient management. The study of biology of fall armyworm as occurring in India is also important for identifying its life stages and thereby planning IPM Strategies. Thus more we know about its biology, more likely able to manage it effectively.

Material and Methods

Culture of fall armyworm was obtained by collecting larvae from the infested maize field at College of Agriculture, Pune. Culture was maintained on laboratory conditions on maize leaves at room temperature (27±3 °C) and relative humidity (70± 5%). Fresh food was provided daily during experimental period. Proper hygienic conditions were maintained. During rearing, requisite care was undertaken for food and space to avoid overcrowding and cannibalism thereby late instar larvae were transferred for pupation to separate sets of containers consisting sieved and sterilized soil layer having depth of around 3 cm. Emerging adults were fed on 10% honey. A folded black paper sheet was placed in the jar to provide suitable sites for oviposition. Freshly laid eggs on leaves were then collected and kept within the incubator for hatching. There after F₁ population was maintained and used for further studies on biology. Eggs, larvae, pupa and adults (10 each) will be studied with 3 replications. The observations on colour of larvae, pupae and adults was recorded. The variation in larval, pupal and adult, pre- oviposition, oviposition, post-oviposition periods, fecundity, longevity, sex ratio was recorded. The length of larva, pupa and adults were also recorded.

Result and Discussion**Egg**

Female oviposits eggs in cluster with 2 or 3 tiers on lower leaf surface, sometimes on upper leaf surface or whorls. Mean fecundity was observed as 1108.6 ± 121.29 eggs per female. Incubation period was noticed as 3.30 ± 0.65 days with hatching rate of 96 per cent. Freshly laid eggs were dorso-ventrally flattened, were pale green, later on turned to golden yellowish and finally appeared somewhat darkish.

Corresponding Author:**P Aarthi Helen**

Department of Entomology
College of Agriculture, Pune
Mahatma Phule Krishi
Vidyapeeth, Rahuri
Maharashtra, India

Larva

Newly hatched larva appeared whitish with large black head with mean duration of 2.8 ± 0.27 days. Second instar was pale yellowish green with duration of 2.5 ± 0.35 days. Third instar was greenish brown, lateral body with white lines whereas, dorsal body surface appeared brownish; larval body bared elevated black spots with visible prominent spines with duration of 2.1 ± 0.22 days. Fourth instar was olive brown to dark brown with average larval duration was 2.2 ± 0.27 days. Fifth instar resembled the fourth instar except the size with mean larval duration was 2.6 ± 0.41 days. Sixth instar was dull grayish brown with black head capsule with prominent inverted 'Y' shaped marking; four black spots were observed in square shape on eighth abdominal segment and with clear and distinct body segmentation; mean larval duration was 4.4 ± 0.41 days. Mean total larval period computed to be 16.6 ± 0.82 days.

Pupa

Late instar larva pupates in soil, up to depth of 2 to 8 cm by webbing leaf debris and soil particles with silken threads by constructing a loose oval shaped earthen cocoon. Newly formed pupa was orange brown then gradually became reddish brown. Average pupal duration was 9.2 ± 1.64 days. The genital opening of female and male pupa bared slit on 8th whereas on 9th abdominal segment, respectively.

Adult

Male moth has grey shaded body with brown forewings and triangular white spots in centre of forewings. Female moth has grayish brown forewings. Hind wings in both the moths are shiny silvery white with narrow white border. Mean body length of male and female from head to abdominal tip was 15.99 ± 0.18 and 15.16 ± 0.69 mm, respectively. Mean wing length of male and female was 14.05 ± 0.12 and 13.31 ± 0.68 mm, respectively. Average wing span of male and female was 31.95 ± 1.01 and 30.82 ± 0.41 mm, respectively.

Mean pre-ovipositional, ovipositional and post-ovipositional period were 3.4 ± 0.55 , 2.8 ± 0.27 and 6.2 ± 0.41 days, respectively. Mean longevity of mated female and male were 12.4 ± 0.54 and 10.4 ± 0.41 days, respectively. The mean life span from egg to moth was 38.2 ± 1.35 days in females and 36.2 ± 1.25 in males.

Morphometrics

Mean length of first, second, third, fourth, fifth and sixth instar was 1.75, 3.54, 6.01, 9.96, 16.82 and 33.27 mm, respectively. Mean pupal length was 15.28 mm. Mean body length of male and female from head to abdominal tip was 15.99 and 15.16 mm, respectively. Mean wing length of male and female was 14.05 and 13.31 mm, respectively. Mean wing span of male and female was 31.95 and 30.82 mm, respectively.



Table 1: Morphometrics of Fall armyworm *Spodoptera frugiperda*

Phases of life stages	Length(mm)	
	Range	Mean SD±
I instar	1.59 – 1.87	1.75 ± 0.11
II instar	3.40 – 3.74	3.54 ± 0.12
III instar	5.56 – 6.42	6.01 ± 0.32
IV instar	9.65 – 10.43	9.96 ± 0.33
V instar	16.24 – 17.46	16.82 ± 1.24
VI instar	31.34 – 34.98	33.27 ± 1.52
Pupa	14.39 – 15.93	15.28 ± 0.78
Adult Male		
Body length	15.78 – 16.23	15.99 ± 0.18
Wing length	13.89 – 14.21	14.05 ± 0.12
Wing Span	30.42 – 32.87	31.95 ± 1.01
Adult Female		
Body length	14.23 – 15.83	15.16 ± 0.69
Wing length	12.43 – 13.98	13.31 ± 0.68
Wing Span	30.23 – 31.21	30.82 ± 0.41

Table 2: Life span of FAW *Spodoptera frugiperda* in laboratory conditions

S N	Phase of Life Stage	Period (days)		
		Range	Mean SD ±	
1	Egg stage			
	Incubation	3-4		
	Hatching percentage (%)	-	96 %	
2	Larval stage			
	Total larval stage	16-18	16.6 ± 0.82	
	First instar larva	2.5-3	2.8 ± 0.27	
	Second instar larva	2.5-3	2.5 ± 0.35	
	Third instar larva	2-2.5	2.1 ± 0.22	
	Fourth instar larva	2-2.5	2.2 ± 0.27	
	Fifth instar larva	2.5-3	2.6 ± 0.41	
3	Pupal stage			
		8-12	9.2 ± 1.64	
4	Adult stage			
	Pre-oviposition	3-4	3.4 ± 0.55	
	Oviposition	2.5-3	2.8 ± 0.27	
	Post-oviposition	6-6.5	6.2 ± 0.41	
	Fecundity of female moth	957-1289	1094 ± 0.92	
	Longevity of female moth	11.5-13	12.4 ± 0.54	
	5	Longevity of male moth	10-11	10.4 ± 0.41
		Egg to adult stage in Female	37-40.5	38.2 ± 1.35
	Egg to adult stage in male	35-38	36.2 ± 1.25	



A.



B.



C.



D.

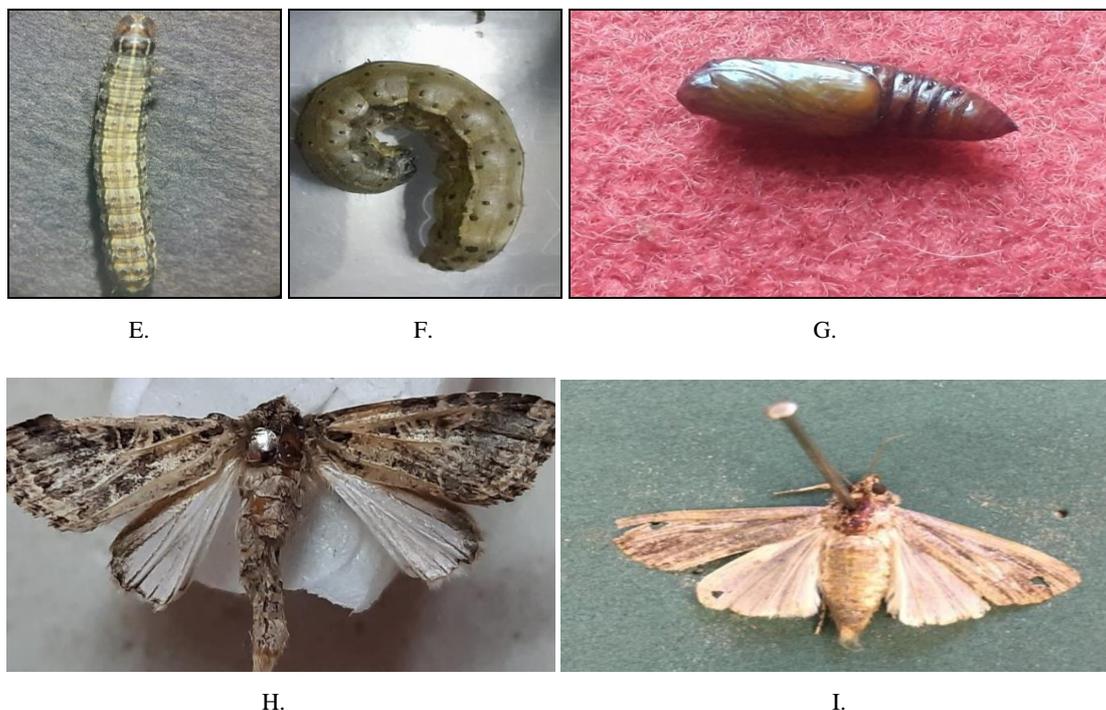


Fig 1: Life stages of fall army worm *S. frugiperda* A- Egg stage, B-G Different larval instars, H- pupal stage, I – Male moth, J- Female moth

Conclusion

Mean life span (egg to adult stage) of male and female was 36.2 and 38.2 days, respectively. Fecundity was in the range of 957-1289 eggs / female. Mean egg hatching was 96 per cent. Incubation period ranged from 3-4 days. Larval period ranged from 16-18 days wherein first, second, third, fourth, fifth and sixth instars were 2.8, 2.5, 2.1, 2.2, 2.6 and 4.4 days, respectively. Pupal period ranged from 8 to 12 days. Longevity of male and female ranged from 11 to 13 and 10 to 11 days, respectively.

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